WEED MANAGEMENT UNDER DIFFERENT PATTERNS OF SUNFLOWER-SOYBEAN INTERCROPPING

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ABSTRACT

Two field experiments were conducted at the Experimental Farm of the National Research Centre at Shalakan, Kalubia Governorate, Egypt during the 2005 and 2006 seasons to study the effect of three weed management {hand hoeing twice, butralin+prometryn and unweeded check} as well as six intercropping patterns {two pure stand crops, besides intercropping sunflower: soybean {sun: soy} alternating ridges 1:1, 1:2, 2:1 as well as side: side}. Results showed that the lowest light intensity was recorded with sole soybean. Hoeing achieved the lowest dry weights of the grassy, broad-leaved and total weeds, but statistically leveled with those of butralin+prometryn in grassy and broad-leaved weeds. The lowest dry weight of grasses was recorded with 1:1 and 1:2 intercropping patterns. Hoeing was the best treatment for promoting sunflower and soybean seed yields/fed. Among the intercropping systems, the pattern of side: side appeared the highest significant sunflower seed yield than the rest of other intercropping ones and could recover maximum of its sole sunflower yield (81.3 %). The highest LER values, i.e. 1.376 and 1.198 recorded when sunflower and soybean intercropped in side: side and 1:2, respectively. The Aggressivity values indicated that sunflower component was the dominated, while soybean was the dominant one.

Key words: weed, intercropping, sunflower, soybean.

INTRODUCTION

There is no doubt that increasing production of vegetable oils became a dire need in Egypt, especially our local production will not exceed 150,000 ton in 2010, meanwhile the consumption will reach 820,000 ton (according to Specialized National Councils) i.e., the ratio of our self-sufficiency will not extend beyond 15 %.

It is well known that the weeds interfere with crops causing serious impacts through either competition (for light, water, nutrients and space) and/or allelopathy. Weed infestation removed 48.2 kg N, 14.4 kg P/ha. in sunflower [27] as well as 21.4 kg N and 3.4 kg P/ha. in soybean [20]. Weeds cause great reduction of sunflower yield ranges from 18.6-36.3 % [16, 24]. Also, a linear decline was observed in seed yield of soybean with the increase in weed biomass [17]. Accordingly, it is essential to control weeds in sunflower and soybean fields. Herein, agricultural methods of weed control, such as intercropping are considered the best now, especially after the contraction of herbicides compounds volume because they have negative environmental effects, but it is indispensable. Intercropping patterns are more effective than monocropping in suppression of weeds, but their effectiveness varies greatly [13]. Also, [2] pointed out that intercropping has a potential to suppress weeds and it offers the possibility of capturing a greater share of available resources than sole crop. This indicates its importance of making use of land. A good intercropping of oilseeds and pulse crops increase total production per unit area as compared to a pure crop [21]. [22, 9] showed that groundnut-sunflower intercropping system is instrumental to maximize the oilseed production per unit and time. The system provides 50 to 75 % yield advantage and net profit. However, sunflower-soybean intercropping system is still not understood well with that of sole cropping especially in terms of its effect on weeds suppression.

Keeping these points of view, this investigation was planned to study the effect of some weed management practices under intercropping patterns of sunflower and soybean on yield and associated weeds.

MATERIALS & METHODS

Two field experiments were conducted at the Experimental Farm of the National Research Centre at Shalakan, Kalubia Governorate, Egypt during 2005 and 2006 summer seasons. The soil texture was clay loam and the preceding crop was wheat in both seasons. Each experiment included 18 treatments which were the combinations of:

(1)- Three weed management treatments, i.e. hand hoeing twice {before the 1st and 2nd irrigation}, butralin+prometryn (herbicides) and unweeded check,

(2)- Six intercropping patterns, i.e. intercropping sunflower: soybean {sun: soy} alternating ridges 1:1, 1:2, 2:1 as well as side: side in addition to the two sole crops.

Butralin herbicide {Amex 50% EC, 4-(1,1-dimethylethyl)-N-(1-methylpropyl)-2,6-dinitrobenzenamine) at the rate of 0.85 l./fed. and prometryn {Gesagard 500 FW, N,N-bis (1-methylethyl)-6-(methylthio)-1,3,5-triazine-2,4-diamine} at the rate of 0.5 l./fed. in sequence was sprayed immediately before the sowing irrigation using knapsack sprayer with one nozzle boom and the carrier was 200 l. water/fed.

A split plots design with four replicates was used, where the main plots were occupied by the weed management treatments, while the intercropping patterns were allocated in the subplots. The experimental unit area was 18.9 m^2, contained 9 ridges (3.5 m length and 0.6 m apart).

Seeds of sunflower (cv.Giza 102) were sown in hills 20 cm apart in one side of ridge, and just after pre-emergence herbicides application (according to the treatments), all experimental plots were irrigated. When the soil moisture was adequate (3-4 days later), the seeds of soybean (cv. Giza 111) were sown in hills 20 cm apart in two both sides of ridge, except in plots which intercropped with side: side pattern, where soybean seeds were sown in one side only. Sowing dates (for sunflower) were June 8th and 10th in the 1st and 2nd seasons, respectively. At complete germination, sunflower and soybean seedlings were thinned to secure one and two plants /hill, respectively. The first irrigation was carried out at 21 days from sunflower sowing. Plants of the two crops were fertilized with 30 kg N/fed. as ammonium sulfate (20.6 % N) in two equal portions before the first and second irrigation, respectively. Phosphorus fertilizer was applied in the form of calcium super phosphate (15 % P_2O_5) at the rate of 150 kg/fed. during soil preparation. After flowering and seed setting, the heads of sunflower plants were protected from birds by covering them using pored paper packages. All recommended agricultural practices were adopted throughout the two seasons.

Data record:

After 80 days from sowing, light intensity was measured at noon (using lux meter LX-101) at 50 cm height from soil surface. In this respect, one observation was made under the canopy of sole sunflower and soybean, and another two observations were made under each crop canopy in intercropped plots, then the average of these two latter readings was recorded.

Weeds were hand pulled from one square meter of each

Table (1): Effect of weed management (A), sunflower-soybean intercropping patterns (B) and their interaction on light intensity (lux) (combined analysis of 2005 and 2006 seasons).

Variables	*Sole sun*	*Sole soy*	*1 sun:1 soy*	*1 sun:2 soy*	*2 sun:1 soy*	*Side: side*	Mean
Hoeing twice	942.0	142.0	712.0	971.0	819.0	829.0	735.8
Butralin+prometryn	869.0	170.0	903.5	613.0	919.5	911.0	731.0
Unweeded	887.0	120.0	940.0	843.0	731.0	924.0	740.8
Mean	899.3	144.0	851.8	809.0	823.2	888.0	
LSD (0.05):	*A: n.s*		*B: 53.8*		*A x B: 93.3*		

Table (2): Effect of weed management (A), sunflower-soybean intercropping patterns (B) and their interaction on dry weight ($g.m^{-2}$) of weeds (combined analysis of 2005 and 2006 seasons).

Variables	***Sole sun***	***Sole soy***	***1 sun:1 soy***	***1 sun:2 soy***	***2 sun:1 soy***	***Side: side***	**Mean**
				Grassy weeds			
Hoeing twice	36.3	19.5	21.7	29.9	27.3	43.9	**29.8**
Butralin+prometryn	81.2	57.8	34.6	51.8	51.6	55.3	**55.4**
Unweeded	121.4	127.1	87.6	85.2	106.3	145.4	**112.1**
Mean	**79.6**	**68.1**	**48.0**	**55.6**	**61.7**	**81.5**	
LSD (0.05):	*A: 27.0*		*B: 25.4*		*A x B: 43.9*		
				Broad-leaved weeds			
Hoeing twice	21.0	0.0	12.1	19.9	19.9	19.2	**15.3**
Butralin+prometryn	51.0	31.4	50.2	43.5	59.9	22.0	**43.0**
Unweeded	90.6	98.4	99.1	109.0	88.5	88.0	**95.6**
Mean	**54.2**	**43.2**	**53.8**	**57.4**	**56.1**	**43.0**	
LSD (0.05):	*A: 31.4*		*B: n.s*		*A x B: 35.1*		
				Total weeds			
Hoeing twice	57.3	19.5	33.8	49.8	47.2	63.1	**45.1**
Butralin+prometryn	132.2	89.2	84.8	95.3	111.5	77.3	**98.4**
Unweeded	212.0	225.5	186.7	194.2	194.9	233.4	**207.8**
Mean	**133.8**	**111.4**	**101.8**	**113.1**	**117.9**	**124.6**	
LSD (0.05):	*A: 32.9*		*B: n.s*		*A x B: 61.9*		

subplot at 90 days from sunflower sowing then dry weights of grasses; broad-leaved as well as total weeds were calculated. The Weeds were identified and their dry weights were recorded.

After maturity, a sample of ten sunflower plants was randomly chosen and harvested from each plot on September 22nd and 25th in the 1st and 2nd seasons, respectively, to measure plant height, head diameter and weight/plant, seed weight/plant, seed index (1000-seed weight) as well as seed yield/fed. Soybean plants were harvested from one middle ridge of each plot on October 17th and 21st in the 1st and 2nd seasons, respectively, to estimate plant height, number of branches and pods/plant, pods weight/plant, seed index (100-seed weight) as well as biological and seed yields/fed. Oil percentage of sunflower and soybean seeds was measured by extraction using Soxhlet Apparatus with hexane as an organic solvent according to [3]. Then, oil yield was calculated per fed. In addition, some competitive relations were calculated, i.e. land equivalent ratio for sunflower (L_{sun}), soybean (L_{soy}) and for the two intercrops (LER) according to [28] as well as Aggressivity for sunflower (A_{sun}) and soybean (A_{soy}) according to [19].

Simple correlation:

All possible coefficients of simple correlation (r) were calculated (according to [25]) among plant height, head diameter and weight/plant, seed index, seed weight/plant and seed yield/fed. in sunflower; plant height, number of branches and pods/plant, pods weight/plant, seed index and seed yields/fed. in soybean under both intercropping systems as well as over all the experiment.

Table (3): Effect of weed management (A), sunflower-soybean intercropping patterns (B) and their interaction on sunflower yield and its components (combined analysis of 2005 and 2006 seasons).

Variables	*Sole sun*	*1 sun: 1 soy*	*1 sun:2 soy*	*2 sun:1 soy*	*Side: side*	**Mean**
			Plant height (cm)			
Hoeing twice	113.7	110.2	116.7	122.9	123.6	**117.4**
Butralin+prometryn	116.6	120.6	120.6	125.7	119.3	**120.5**
Unweeded	114.1	109.7	110.9	113.1	116.9	**112.9**
Mean	**114.8**	**113.5**	**116.0**	**120.6**	**119.9**	
LSD (0.05):	*A: 5.6*		*B: 5.5*		*A x B: 9.6*	
			Head diameter (cm)			
Hoeing twice	12.6	13.0	11.8	12.7	12.6	**12.5**
Butralin+prometryn	11.8	12.7	13.1	12.7	11.4	**12.3**
Unweeded	11.1	10.8	10.7	11.0	10.6	**10.8**
Mean	**11.8**	**12.2**	**11.8**	**12.1**	**11.5**	
LSD (0.05):	*A: 0.4*		*B: n.s*		*A x B: 0.8*	
			Head wt. plant^{-1} (g)			
Hoeing twice	64.7	59.5	46.7	60.3	51.2	**56.5**
Butralin+prometryn	60.0	63.8	63.0	82.5	68.8	**67.6**
Unweeded	38.9	53.5	54.8	42.9	33.7	**44.7**
Mean	**54.5**	**58.9**	**54.8**	**61.9**	**51.2**	
LSD (0.05):	*A: 15.7*		*B: n.s*		*A x B: 25.0*	
			seed wt. plant^{-1} (g)			
Hoeing twice	24.7	26.9	20.5	25.5	26.3	**24.8**
Butralin+prometryn	26.7	28.0	32.5	27.6	20.4	**27.0**
Unweeded	20.7	15.9	18.4	18.4	16.6	**18.0**
Mean	**24.0**	**23.6**	**23.8**	**23.8**	**21.1**	
LSD (0.05):	*A: 1.1*		*B: 1.2*		*A x B: 2.2*	
			seed index (g)			
Hoeing twice	68.4	70.0	64.9	71.8	67.9	**68.6**
Butralin+prometryn	65.3	72.9	69.7	69.0	61.1	**67.6**
Unweeded	60.7	61.3	62.0	58.3	58.1	**60.1**
Mean	**64.8**	**68.1**	**65.5**	**66.3**	**62.4**	
LSD (0.05):	*A: 3.2*		*B: 3.2*		*A x B: 5.6*	
			Seed yield (kg fed.$^{-1}$)			
Hoeing twice	1029.8	425.1	205.3	650.6	942.1	**650.6**
Butralin+prometryn	974.5	452.5	316.0	674.8	768.1	**637.2**
Unweeded	722.6	237.0	147.1	437.6	509.5	**410.8**
Mean	**909.0**	**371.5**	**222.8**	**587.7**	**739.9**	
LSD (0.05):	*A: 69.4*		*B: 67.3*		*A x B: 116.6*	

Statistical analysis:

All the obtained data from each season were exposed to the proper statistical analysis of variance according to [25]. The combined analysis of variance for the data of the two seasons was performed, after testing the error homogeneity, the LSD at 0.05 level of significance was used for the comparison between means.

RESULTS

1-Light intensity:

Light intensity was significantly influenced by the intercropping patterns, but not affected by weed management treatments (Table, 1). Light transmission in sole sunflower plots along with side: side intercropping pattern was significantly higher compared to other patterns, except 1:1 one. Meanwhile, the light intensity with sole soybean was the lowest. Moreover, the presence of soybean and sunflower plants together in 1:2 and 2:1 patterns markedly reduced light transmission by 10.0 and 8.5 %, respectively, relative to sole sunflower.

Remarkable interaction effect between weed management and intercropping patterns on light intensity was observed (Table, 1). Therein, the maximum value was recorded with 1:2 pattern x hoeing twice, while sole soybean plants grown in the unweeded plots intercepted the most light and transmitted the least.

2-weed growth:

The dominant weeds in the two seasons of the

Table (4): Effect of weed management (A), sunflower-soybean intercropping patterns (B) and their interaction on soybean yield and its components (combined analysis of 2005 and 2006 seasons).

Variables	***Sole soy***	***1 sun: 1 soy***	***1 sun:2 soy***	***2 sun:1 soy***	***Side: side***	**Mean**
			Plant height (cm)			
Hoeing twice	86.9	85.3	96.3	89.5	85.9	**88.8**
Butralin+prometryn	81.1	89.0	95.4	93.1	82.1	**88.1**
Unweeded	84.9	85.8	89.5	83.9	75.7	**83.9**
Means	**84.3**	**86.7**	**93.7**	**88.8**	**81.2**	
LSD (0.05):	*A: n.s*		*B: 3.9*		*A x B: 6.7*	
			Branches no.plant^{-1}			
Hoeing twice	2.51	3.68	3.36	3.45	3.23	**3.25**
Butralin+prometryn	3.63	3.13	2.83	2.65	2.68	**2.98**
Unweeded	2.23	2.53	2.06	2.81	2.70	**2.47**
Means	**2.79**	**3.11**	**2.75**	**2.97**	**2.87**	
LSD (0.05):	*A: 0.42*		*B: n.s*		*A x B: 0.88*	
			Pods no. plant^{-1}			
Hoeing twice	53.3	71.5	71.4	72.0	78.3	**69.3**
Butralin+prometryn	47.9	58.6	56.6	59.4	52.0	**54.9**
Unweeded	45.1	49.9	54.0	56.8	40.1	**49.2**
Means	**48.8**	**60.0**	**60.6**	**62.7**	**56.8**	
LSD (0.05):	*A: 10.1*		*B: 9.0*		*A x B: 15.7*	
			Pods wt plant^{-1} (g)			
Hoeing twice	29.8	38.0	39.8	36.8	40.8	**37.0**
Butralin+prometryn	25.4	31.7	30.1	28.3	31.5	**29.4**
Unweeded	18.4	23.2	26.5	26.7	23.6	**23.2**
Means	**24.5**	**30.9**	**32.1**	**30.6**	**32.0**	
LSD (0.05):	*A: 5.4*		*B: 4.4*		*A x B: 7.7*	
			Seed wt. plant^{-1} (g)			
Hoeing twice	19.9	24.2	25.8	23.8	25.9	**23.9**
Butralin+prometryn	15.2	20.2	19.1	18.2	20.5	**18.7**
Unweeded	11.6	14.7	16.9	16.9	15.1	**15.0**
Means	**15.6**	**19.7**	**20.6**	**19.6**	**20.5**	
LSD (0.05):	*A: 3.5*		*B: 2.8*		*A x B: 4.9*	
			seed index (g)			
Hoeing twice	19.6	19.7	21.5	21.3	19.6	**20.3**
Butralin+prometryn	17.9	19.9	21.4	19.1	19.4	**19.5**
Unweeded	19.0	18.8	19.7	19.1	19.2	**19.1**
Means	**18.8**	**19.5**	**20.8**	**19.8**	**19.4**	
LSD (0.05):	*A: 0.3*		*B: 0.5*		*A x B: 0.9*	
			Biological yield (ton fed.$^{-1}$)			
Hoeing twice	6.421	3.581	5.237	2.575	2.988	**4.161**
Butralin+prometryn	5.396	3.368	4.786	2.223	2.565	**3.668**
Unweeded	3.108	1.720	3.070	0.948	1.664	**2.102**
Means	**4.975**	**2.890**	**4.364**	**1.916**	**2.406**	
LSD (0.05):	*A: 0.600*		*B: 0.492*		*A x B: 0.853*	
			Seed yield (ton fed.$^{-1}$)			
Hoeing twice	2.316	1.369	2.408	0.978	1.322	**1.679**
Butralin+prometryn	1.901	1.282	1.770	0.833	1.081	**1.373**
Unweeded	1.384	0.726	1.166	0.419	0.748	**0.889**
Means	**1.867**	**1.126**	**1.781**	**0.744**	**1.050**	
LSD (0.05):	*A: 0.264*		*B: 0.184*		*A x B: 0.319*	

experimentation, were mostly grassy, i.e. Echinochloa colonum, (L.) Link. and Dactyloctenium aegyptium, (L.) P. Beauv., in addition to a few broad-leaved ones, i.e. Portulaca oleracea, L. and Hibiscus trionum, L..

Available results in Table (2) reveal that the dry weights of grassy, broad-leaved and total weeds were reduced by weeding practices. In this connection, hoeing twice achieved the highest weed depression of dry weights of the mentioned weed groups. Reduction percentage recorded with such potent treatment relative to unweeded one was

Table (5): Effect of weed management (A), sunflower-soybean intercropping patterns (B) and their interaction on seed oil % and yield of sunflower (combined analysis of 2005 and 2006 seasons).

Variables	*Sole sun*	*1 sun: 1 soy*	*1 sun:2 soy*	*2 sun:1 soy*	*Side: side*	**Mean**
			Oil %			
Hoeing twice	51.3	44.9	50.6	49.6	44.6	**48.2**
Butralin+prometryn	52.9	51.8	57.6	55.5	56.7	**54.9**
Unweeded	57.4	49.5	47.6	56.1	52.8	**52.7**
Mean	**53.8**	**48.8**	**51.9**	**53.7**	**51.3**	
LSD (0.05):	*A: n.s*		*B: 4.1*		*A x B: 7.2*	
			Oil yield (kg fed.$^{-1}$)			
Hoeing twice	537.7	205.2	94.8	347.9	418.3	**320.8**
Butralin+prometryn	532.4	265.3	166.7	410.0	469.0	**368.7**
Unweeded	418.7	128.9	68.9	227.3	271.6	**223.1**
Mean	**496.3**	**199.8**	**110.1**	**328.4**	**386.5**	
LSD (0.05):	*A: 42.1*		*B: 21.6*		*A x B: 37.4*	

amounted to 73.4, 84.0 and 78.3 % in grassy, broad-leaved and total weeds, respectively, but statistically leveled with those of butralin+prometryn which recorded 50.0 and 55.0 % control in grassy and broad-leaved weeds, respectively.

Concerning the impact of intercropping patterns on growth of annual weed categories, data presented in Table (2) show that there is a significant effect on dry weight of grassy weeds. Both of broad-leaved and total weeds were not affected. The least dry weight values of grassy weeds were recorded by 1:1 and 1:2 intercropping patterns reaching the significance level than the most infested one, i.e. side: side. Cultivating soybean alone caused slight reduction in the growth of grassy weeds compared to sole sunflower.

Remarkable impact of the interaction among weed management treatments and intercropping patterns on dry weight of grassy, broad-leaved and total weeds was obtained (Table, 2). Under hoeing twice treatment, plots cultivated with solid soybean achieved the minimum dry weight of grassy, broad leaved and total weeds.

3-Yield and its attributes:

a)- Sunflower:

Weed management practices had a significant effect on yield and yield attributes (Table, 3). Application of butralin+prometryn resulted in increment of plant height, head weight and seed weight/plant, amounted by 7, 51 and 50 %, respectively, compared to unweeded check. Moreover, hoeing was the best treatment for promoting head diameter, seed index and seed yield/fed, exceeding the unweeded by 16, 14 and 58 %, respectively.

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Planting sunflower in 2:1 pattern secured the tallest plants along with that of 1:2 and side: side (Table,3). Seed weight/plant was the highest in sole sunflower, surpassing side: side pattern. The pattern of 1:1 surpassed sole sunflower and side: side pattern in 1000-seed weight. While, sole sunflower surpassed all intercropping patterns in seed yield/fed. Such efficient treatment outyielded seed yield than 1:2, 1:1, 2:1 and side: side patterns by 307.9, 144.6, 54.6 and 22.8 %, respectively. Among the intercropping systems, growing sunflower more closely with soybean (in side: side pattern) attained the lowest values of seed weight/plant and 1000-seed weight. On the other hand, intercropping patterns varied greatly in their impact on seed yield of sunflower, where side: side appeared the highest significant value than the rest of intercropping patterns. Herein, side: side pattern could recover maximum of its sole crop yield (81.3 %) owing to the establishment of sunflower plants.

The interaction between weed management and intercropping patterns divulged remarkable impact on plant height, head diameter and weight/plant, seed weight/plant, seed index as well as seed yield/fed. Therein, application of butralin+prometryn resulted in the maximum values of plant height and head weight/plant, head diameter and seed weight/plant as well as 1000-seed weight in 2:1, 1:2 1:1 patterns, respectively. Contrariwise, pure stand of sunflower plants gained their maximum seed yield/fed. in plots hand hoed two times.

b)- Soybean:

Significant differences were observed by weed management practices in number of branches and pods/plant, pods and seed weight/plant, 100-seed weight as well as biological and seed yields/fed (Table, 4). In this regard, the weeded treatments surpassed the unweeded one in all traits, except plant height where there was no difference. In addition, hoeing twice was the superior treatment for increasing number of pods/plant, pods and

Table (6): Effect of weed management (A), sunflower-soybean intercropping patterns (B) and their interaction on seed oil % and yield of soybean (combined analysis of 2005 and 2006 seasons).

Variables	*Sole soy*	*1 sun: 1 soy*	*1 sun:2 soy*	*2 sun:1 soy*	*Side: side*	**Mean**
			Oil %			
Hoeing twice	26.1	25.4	24.5	24.3	25.1	**25.0**
Butralin+prometryn	26.3	24.2	25.1	24.9	25.1	**25.1**
Unweeded	24.5	24.5	23.9	24.1	24.4	**24.3**
Means	**25.6**	**24.7**	**24.5**	**24.4**	**24.9**	
LSD (0.05):	*A: n.s*		*B: 0.9*		*A x B: 1.6*	
			Oil yield (kg fed.$^{-1}$)			
Hoeing twice	606.6	345.0	584.1	238.2	330.4	**420.9**
Butralin+prometryn	499.7	321.4	433.1	207.2	273.2	**346.9**
Unweeded	344.2	167.0	323.3	97.2	179.9	**222.3**
Means	**483.5**	**277.8**	**446.8**	**180.9**	**261.2**	
LSD (0.05):	*A: 12.6*		*B: 12.5*		*A x B: 21.7*	

Table (7): Simple correlation coefficients (r) among plant height, head diameter and weight/plant, seed index, seed weight/plant and seed yield/fed. in sunflower under both intercropping systems as well as over all the experiment.

Variables	**1**	**2**	**3**	**4**	**5**
			Under intercropping systems		
Plant height (1)					
Head diameter (2)	0.527**				
Head weight (3)	0.727**	0.523**			
Seed index (4)	0.133	0.513**	0.172		
Seed weight/plant (5)	0.662**	0.760**	0.710**	0.294*	
Seed yield (6)	0.633**	0.471**	0.535**	0.104	0.543**
			Under over all		
Plant height (1)					
Head diameter (2)	0.498**				
Head weight (3)	0.733**	0.512**			
Seed index (4)	0.114	0.521**	0.173		
Seed weight/plant (5)	0.687**	0.720**	0.728**	0.264*	
Seed yield (6)	0.550**	0.402**	0.498**	0.071	0.541**

* Significant at 0.05 level of probability
** Significant at 0.01 level of probability

seed weight/plant, 100-seed weight as well as seed yield/fed.

All soybean yield and its parameters were affected markedly by intercropping patterns except branches number/plant (Table, 4). The maximal increases of plant height, pods and seed weight /plant as well as 100-seed weight were produced from 1:2 pattern, while 2:1 pattern appeared the highest pods number/plant. On the other hand, plots cultivated with soybean alone exceeded all intercropping pattern in biological and seed yield except 1:2 pattern in seed yield. Among the intercropping patterns, 1:2 system was the excelsior practice for promoting soybean yields surpassing other intercropping practices. Contrarily, soybean intercropped with sunflower in 2:1 pattern recorded the minimal values in biological and seed yields.

Obvious impact of the interaction between weed management and intercropping patterns on soybean yield and its attributes (Table, 4). In this regard, plots hand hoed two times appeared their potency in plant height, 100-seed weight and seed yield/fed. with 1:2 pattern, branches number/plant with 1:1 pattern as well as pods number and weight/plant and seed weight/plant with side: side pattern. Moreover, biological yield/fed. was highest with using hoeing twice in sole soybean. It is observed that application of hand hoeing twice in combination with planting soybean either in pure stand or in two ridges alternative with one sunflower ridge produced the highest and superior soybean seed production.

4- Oil % and yield:

a)- Sunflower:

Table (8): Simple correlation coefficients (r) among plant height, number of branches and pods/plant, pods weight/plant, seed index and seed yields/fed. in soybean under both intercropping systems as well as over all the experiment.

Variables	1	2	3	4	5	6
			Under intercropping systems			
Plant height (1)						
Branches number (2)	0.123					
Pods number (3)	0.410**	0.501**				
Pods weight/plant (4)	0.343**	0.479**	0.814**			
Seed weight/plant (5)	0.334**	0.514**	0.770**	0.988**		
Seed index (6)	0.315**	0.433**	0.244*	0.332**	0.360**	
Seed yield (7)	0.475**	0.357**	0.410**	0.544**	0.577**	0.535**
			Under over all			
Plant height (1)						
Branches number (2)	0.210*					
Pods number (3)	0.446**	0.442**				
Pods weight/plant (4)	0.333**	0.382**	0.799**			
Seed weight/plant (5)	0.322**	0.392**	0.761**	0.987**		
Seed index (6)	0.364**	0.375**	0.307**	0.352**	0.391**	
Seed yield (7)	0.372**	0.255*	0.278**	0.349**	0.369**	0.246*

* Significant at 0.05 level of probability
** Significant at 0.01 level of probability

Results evident that no definite effect was found for weed management treatments on oil % of sunflower seeds, but oil yield/fed. was affected, (Table, 5). Butralin+prometryn treatment achieved significantly the highest oil yield, more than the unweeded check by 44 %.

Mean values of intercropping patterns clear that solid sunflower surpassed 1:1 pattern in oil %, but still remained equal with the other rest intercropping patterns and markedly exceeded all intercropping patterns in oil yield/fed.

Interaction results suggested that butralin+prometryn x 1:2 pattern or hoeing twice x solid sunflower combinations secured the highest values of oil % and oil yield, respectively

b)- Soybean:

Weed management practices had insignificant effect on oil percentage (Table, 6). However, the oil yield was increased with hoeing treatment by 76 %, compared to unweeded check."

In the second order, intercropping patterns had a significant effect on both oil % and oil yield/fed. of soybean. In this regard, pure stand of soybean recorded the maximum increase in the two mentioned traits. Among the intercropping patterns, 1:2 pattern exceeded the other ones in oil yield/fed.

Regarding the interaction between weed management and intercropping patterns, butralin+prometryn (in oil content) and hoeing twice (in oil yield) each with sole soybean were the most effective.

5- Interspecific competition:

Effects of intercropping patterns on competitive relationships, i.e. land equivalent ratio and aggressivity of sunflower and soybean are diagramed in Figures (1 & 2).

All intercropping patterns exhibited land equivalent ratio (LER) greater than unity. Herein, the highest LER values, i.e. 1.376 and 1.198 recorded when sunflower and soybean were intercropped in side: side and 1:2 patterns, respectively, (Fig 1). Herein, the individual sunflower factor (L_{sun}) was the highest with side: side pattern, while that of soybean (L_{soy}) was the highest with 1:2 one.

According to Fig (2), the aggressivity (A) values were negative for sunflower (A_{sun}), but for soybean (A_{soy}) were positive.

6- Simple correlation:

In this part of study, the aim was to detect the direction and strength of the associations among the involved traits. With respect to sunflower associations, data in Table (7) reveal that all possible coefficients of correlation of

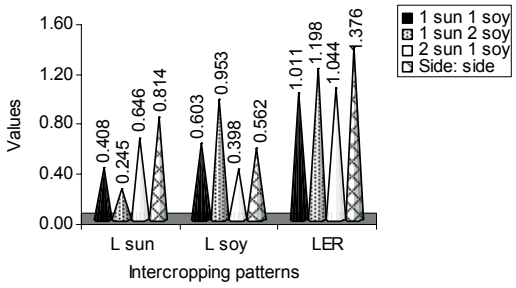

Fig (1): Effect of intercropping patterns on land equivalent ratio of sunflower and soybean.

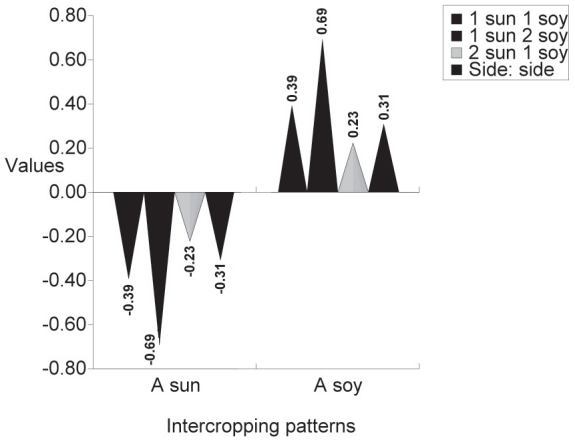

Fig (2): Effect of intercropping patterns on aggressivity of sunflower and soybean.

seed yield were positive and highly significant with all involved traits except its association with seed index. The correlation coefficients of latter trait were not significantly associated with plant height and head weight/plant. Moreover, seed index was positively correlated with seed weight/plant, but at 5 % level of significance only. The rest of correlation coefficients were positive and highly significant. This is true under both intercropping systems and under over all level.

As to soybean, seed yield was positive and high significantly correlated with other involved traits (Table 8). Furthermore, the association between plant height with branches No./plant was not significant under intercropping systems and was positive reaching the 5 % level of significance under the over all level. Under over all level, the association of pods No. /plant with seed index was positive and highly significant as well as seed index was positively correlated with seed yield, but at 5 % level of significance only. All other correlation coefficients of soybean were positive and highly significant.

DISCUSSION

Light intensity:

The higher values of light transmission recorded in sole sunflower plots along with side: side intercropping pattern could be due to the erect growth habit of sunflower plants with relatively more open canopy. While, the reduced light transmission when soybean and sunflower plants were grown together in 1:2 and 2:1 patterns may be attributed to the intense vegetative canopy of soybean plants, so the decrease in light penetration through such canopy is expected.

Weeds:

With regard to the high efficient treatments (i.e. hand hoeing twice and the combination of butralin+prometryn) in controlling weeds, conventional hand hoeing twice can be expressed as the potent effective treatment with respect to weed elimination in sunflower-soybean situations and also as a safety clean non-chemical weed control method with point of view of environmental conservation. Many investigators have been confirmed that hoeing twice is the most effective weed control practice for diminishing the weed dry matter accumulation in sunflower and soybean fields [7, 12, 15, 26, 17]. Furthermore, butralin herbicide effectively controls grasses and some broad-leaf weeds [14], while prometryn controls annual broad-leaved and some grasses [29]. The major effect of dinitroanilines (e.g. butralin) is on the growth of roots, the shoots that emerge often appear quite normal, but soon die because of failure of secondary root development. Prometryn is absorbed through roots from soil application and translocated to shoots, and inhibits photosynthesis resulting in blocking electron transport leading to stopping CO_2 fixation and production of ATP and $NADPH_2$. So, the integration between the two complementary herbicides- butralin and prometryn- is expected to broaden the spectrum of controlled weed species, in addition to reducing the dosage of each to 50 % of their recommended rates. Hereof, both of environmental pollution and weed control costs will be decreased. In this respect, successful integrated chemical weed control results in sunflower and soybean were observed by [12, 6].

The efficiency of 1:1 and 1:2 intercropping patterns on dry weight values of grassy weeds may be due to the more solar radiation intercepted by intercropping system canopy and transmitted through the canopy, and vice versa (Table 1). Similar trend was obtained by [8].

Sunflower:

Application of butralin+prometryn or hoeing twice rid the sunflower plants of weed competition early and the mortality impact of such treatments on weeds remains along the critical period of weed competition, until the plants cover the soil surface. This enables sunflower plants to make good use of the environmental resources, reflecting in improving yield and its components. These results are in harmony with those obtained by [10,12]. The lowest attained values of seed weight/plant and 1000-seed weight recorded when sunflower was grown more closely with soybean (in side: side pattern) might be due to the more intensive competition imposed by either sunflower plants itself or by soybean ones, i.e. intra- and inter-specific competition, respectively. Similar findings were obtained by [23]. On the other hand, the increment in sunflower oil yield/fed. under the superior weeded treatments (specially butralin+prometryn combination)

or with solid sunflower over the intercropping patterns might be attributed to enhancing seed yield (Table, 3). Successful integrate chemical weed control in sunflower was recorded by [16].

Soybean:

The enhancement of yield and its components of soybean in the weeded treatments might be attributed to the high efficiency in elimination of weeds (Table, 2) and consequently decreased the competitive ability of weeds against crop plants. In addition, there is an important role of hoeing in improving soil properties, i.e. soil structure, aeration, water penetration and the availability of some nutrients. In this respect, the increments due to application of hand weeding twice than weedy check were reported in branches and pods number/plant [17], in pods weight/plant [15] and seed yield/fed. [20]. Superiority of the intercropping patterns, 1:2 system for promoting soybean yields surpassing other intercropping practices may be attributed to the highest number of soybean plants (crop population) in 1:2 pattern (67 % of the theoretical number of the sole) relative to other ones. So, the minimal values in soybean yields were expected when soybean intercropped with sunflower in 2:1 pattern. These results are in close agreement with those reported by [11]. The increase in seed yield reflected on increasing oil yield as shown with weeded treatments and 1:2 pattern.

Interspecific competition:

Gaining land equivalent ratio (LER) greater than unity by either intercropping pattern indicates greater biological efficiency of sunflower/soybean intercropping, and thereby resulting in higher productivity per unit area. This revealed a higher degree of efficiency and compatibility of the intercrop system soybean in sunflower particularly with those systems which provided the maximum advantages. Increasing LER values when sunflower and soybean were intercropped in side: side and 1:2 patterns (Fig 1) is in accordance with that obtained by [23]. Also, [18] reported that yield advantage from intercropping compared to sole cropping is attributed to mutual complementary effect of component crops, such as better use of available resources like soil N, moisture and biological nitrogen fixation. With respect to the aggressivity (A), the negative values for sunflower (A_{sun}) and the positive ones for soybean (A_{soy}), Fig. (2), indicate that sunflower component was the dominated, while soybean was the dominant one. The same trend was noticed by [5].

Simple correlation:

Positive and highly significant correlation coefficients were reported among seed yield with head diameter and seed weight/head [1, 10].

Soybean seed yield was found to be positively and significantly correlated with seed weight/plant, number of branches and pods/plant as reported by [4].

REFERENCES

[1] Abdel-Aal S.M., Studies on proper time after flowering until harvest for certain sunflower varieties. Egypt.J.Agron (1992) 17 (1-2): 1-14.

[2] Altier M.A. and Liebman M., Insect, weed and disease management in multiple cropping systems (In): Multiple Cropping Systems. Francis C.A. (ed).Mc-Millan Publishing Co., New York, 1986

[3] A.O.A.C., Association of official agriculture chemists "Official Methods of Analysis" 13th Ed., Washington, DC, USA, 1980

[4] Ashoub M.A., El-Zeiny H.A., El-Bially M.E., El-Noemani A.A.and Kassab O.M., The relative importance of yield components in the soybean variety Clark. Ann. Agric.Sci., Ain Shams Univ., Cairo (1994) 39 (1): 219-226.

[5] Attia A.N. and El-Bially M.E., Interspecific competition and yield advantages of some summer crops as affected by intercropping patterns and nitrogen rates. Proc. 4th Conf.Agron., Cairo, Egypt (1990) 15-16 Sept., 11: 613-625.

[6] Behera U.K., Singh U.and Singh Y.V., Influence of weed-control on productivity of soybean (Glycine max) in Vertisol of central India. Indian J.Agron. (2005) 50 (3): 221-224.

[7] Bochare P.A., Shelke D.K., Bhosle R.H., Jadhav N.S.and Salunke V.D., Weed management in kharif sunflower.J.Maharashtra Agric.Univ. (1992) 17 (3): 503-504.

[8] Devaranavadgi S.B., Hunashal C.S., Patil M.B., Enkatesh H.V and Wali S.Y., Effect of alley cropping on light transmission ratio, growth and yield of winter sorghum (Sorghum bicolor) under semi-arid environment. Indian J.Agron. (2003) 48 (2): 108-110.

[9] Devidayal and Reddy P.S., Effect of intercropping sunflower in different patterns of groundnut on yield and economics in Saurashtra region of Gujarat. Indian J.Agric.Sci. (1991) 61: 490-492.

[10] El-Bially M.E. and Abd-El-Samie F.S., Integrated weed management in sunflower.Ann.Agric.Sci., Ain Shams Univ., Cairo (1997) 42 (1): 147-158.

[11] El-Douby K.A., Habbak K.E., Khalil H.E.and Attia M.Z., Effect of some intercropping patterns on growth and yield of maize and soybean. Ann.Agric.Sci. Moshtohor (1996) 34 (3): 919-933.

[12] Giri A.N., Bhosle R.H.and Lokhande O.G., Performance of cultural, chemical and integrated weed-control methods in sunflower (Helianthus annuus). Indian J.Agron. (1998) 43 (1): 143-148.

[13] Girjesh G.K. and Patil V.C., Weed management studies in groundnut and sunflower intercropping system. J.Oilseeds Res. (1991) 8: 7-13.

[14] Hassall K.A., The Biochemistry & Uses of Pesticides. 2nd Ed. Macmillan Press Ltd., London,1990.

[15] Jan V.K., Chauhan Y.S., Bhargava M.K.and Sharma A.K., Chemical weed control in soybean (Glycine max). Indian J.Agron. (2000) 45 (1): 153-157.

[16] Jat R.and Giri G., Influence of nitrogen and weed-control measures on weed growth, and seed and oil yields of sunflower (Helianthus annuus). Indian J.Agron. (2000) 45 (1): 193-198.

[17] Kushwah S.S.and Vyas M.D., Herbicidal weed control in soybean (Glycine max). Indian J.Agron. (2005) 50 (3): 225-227.

[18] Mandal B.J., Dhara M.C., Mandal B.B., Das S.K.and Nandy R., Rice, mungbean, soybean, peanut and black gram yields under different intercropping systems. Agron.J. (1990) 82: 1063-1066.

[19] Mc Gilchrist C.A., Analysis of competition experiments. Biometrics (1965) 21: 975-985.

[20] Pandya N., Chouhan G.S.and Nepalia V., Effect of varieties, crop geometries and weed management on nutrient uptake by soybean (Glycine max) and associated weeds. Indian J.Agron. (2005) 50 (3): 218-220.

[21] Prasad K. and Srivastava V.C., Pigeonpea (Cajanus cajan) and soybean (Glycine max) intercropping systems under rainfed situation. Indian J.Agric.Sci. (1991) 61: 243-246.

[22] Samui R.C. and Roy A., Possibilities of increasing production of oilseeds through intercropping system. J.Oilseeds Res. (1990) 7: 14-21.

[23] Sarkar R.K., Goswami S.and Pal P.K., Production potential and economic feasibility of sunflower (Helianthus annuus) and pigeonpea (Cajanus cajan) intercropping system on rainfed upland condition. Indian J.Agron. (2003) 48 (4): 263-266.

[24] Singh V.B.and Giri G., Influence of intercropping and weed-control measures on suppression of weeds and productivity of spring season sunflower (Helianthus annuus) and groundnut (Arachis hypogaea). Indian J.Agron. (2001) 46 (3): 440-444.

[25] Snedecor G.W.and Cochran W.G., Statistical methods 7th Ed. Iowa State Univ.USA, 1980.

[26] Vyas M.D., Singh S.and Singh P.P., Weed management in soybean {Glycine max (L.) Merill}. Ann. Plant Protection.Sci. (2000) 8 (1): 76-78.

[27] Wanjari R.H., Yaduraju N.T.and Ahuja K.N., Nutrient uptake by sunflower (Helianthus annuus) and associated weeds during rainy season. Indian J.Agron. (2001) 46 (3): 541-546.

[28] Willey R.W.and Osiru S.O., Studies on mixtures of maize and beans (Phaseolus vulgaris) with particular reference to plant population. J.Agric.Sci.Cambridge, (1972) 79: 519-529.

[29] WSSA (Weed Science Society of America), Herbicide Handbook 7th Ed. Champaign, Illinois, USA, 1994.